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ROTATING BIOLOGICAL CONTACTORS: U.S. OVERVIEW

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16. ABSTRACT

Rotating biological contactors (RBCs) are relatively new to secondary wastewater treatment in the United States, with over 500 municipal facilities being installed in the last decade. In addition to secondary treatment applications, RBCs have also been used successfully to upgrade marginal treatment facilities and to provide nitrification. Because of a variety of problems related to the design, construction, operation, and application of RBC facilities throughout the country, the U.S. Environmental Protection Agency has undertaken a number of research projects to investigate and identify the nature and extent of these problems and to determine possible solutions. These efforts have indicated that when properly designed, built, and operated, RBCs can provide an acceptable alternative biological treatment system.

Approximately 70 percent of the RBC systems operating in the United States and Canada are designed for organic carbon removal only, 25 percent for combined organic removal and nitrification, and 5 percent for nitrification of secondary effluent.

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All RBC systems are cylindrical-type structures consisting of plastic media attached to and/or supported by horizontal rotating shafts. The first commercial RBC system was installed in West Germany in 1960. Units constructed from this time to the early 1970s used flat 0.5-in. thick, 6.5- to 10-ft diameter expanded polystyrene discs. All present systems use thin (0.04 to 0.06 in.), high density plastic media either formed as discs or sections of discs and aligned perpendicular to the shaft, or spirally wound onto and aligned parallel to the shaft. The media configuration, method of media attachment to the shaft, available surface area per unit shaft length, method of rotating the shaft, etc., vary with each manufacturer.

Approximately 70 percent of the RBC systems operating in the United States and Canada are designed for organic carbon removal only, 25 percent for combined organics removal and nitrification, and 5 percent for nitrification of secondary effluent (1). When used for these applications, the RBC shafts are positioned over the wastewater surface such that about 40 percent of the media is submerged at any time. The shafts are rotated slowly (1 to 2 rpm) causing an alternating exposure of the media to the atmosphere and the wastewater. Biological growth (biofilm) becomes attached to the surface of the media and forms a slime layer over the entire surface of the discs. The biological population that develops on each unit reflects the environmental and loading conditions unique to each shaft, and simple visual observation reveals a gradation in slime thickness and color in staged systems. The rotation of the discs alternately contacts the biofilm with organic material in the wastewater and then with the air. Shearing forces exerted on the biofilm as it passes through the wastewater cause excess biological growth to be sloughed off the media into the stage liquor where the turbulence created by disc rotation maintains the sloughed biomass in suspension.

A typical RBC application for secondary treatment is depicted in Figure 1. Here, flow passes from the primary clarifier through the series arrangement of RBC units and then to a final clarifier where the excess biofilm sheared from the RBC is settled. In some installations, screens are used in place of primary clarifiers with a resultant increased solids and biochemical oxygen demand (BOD) load to the RBC system. If the RBC unit was receiving a secondary effluent and was designed to provide nitrification, a clarifier following nitrification would not necessarily be required.

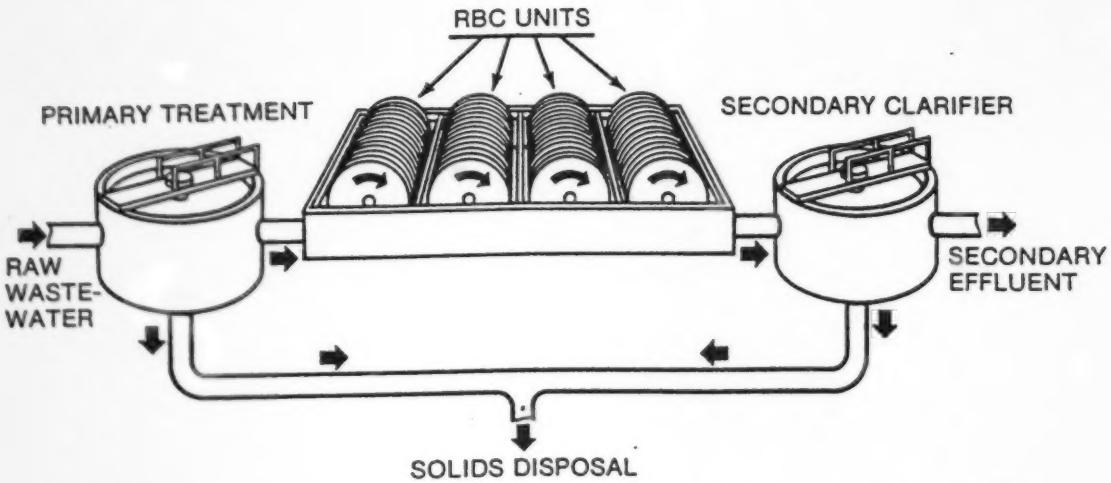

Figure 1. Typical RBC plant schematic for secondary treatment application (2)

An EPA-sponsored study (3) of RBC facilities was conducted during the period of September 1979 through September 1982. Onsite visits and telephone interviews were utilized to collect pertinent operation and maintenance (O&M) and equipment-related data from 16 plants equipped with polyethylene media. For the 153 units included in this evaluation, 41 broken shafts, seven media attachment failures, and 16 bearing failures were reported.

Details of this study and following investigations are provided in References (4) and (5). Based on these studies, a suggested design approach was provided (6), the highlights of which were the following:

1. First-stage RBC organic loading should be limited to 6.0 to 8.0 lbs. total BOD_5/1,000 ft^2 of total media surface · day or 2.5 to 4.0 lbs. soluble BOD_5 /1,000 ft^2 · day. Loadings at the low end of this range were found to be relatively problem free, while those at the high end of this range had an incidence rate of overloading problems three times greater (7).

2. Designs should employ load cells for all first- and second-stage shafts and a means to strip excess biofilm growths, such as air or water stripping, chemical additives or operational speed/direction controls.

3. Raw municipal wastewater should not be applied to an RBC system. Effective preliminary treatment is essential for good operation. Grit removal and either primary clarifiers or screens are necessary to remove materials that may settle in the RBC tankage or plug the RBC media. High influent grease loads require the use of primary clarifiers or an alternate system for grease removal prior to the RBC units. High sulfide concentrations require preaeration to prevent the growth of sulfide-oxidizing organisms.

4. Maximum peak to average flow ratios of about 2.5 can be tolerated without consideration of equalization measures.

5. Dissolved oxygen (DO) monitoring should be provided to ensure positive DO in the first and all other stages of the RBC system, and it should be combined with flexible flow and supplemental air controls.

6. Small-diameter RBC pilot units can only be used to determine treatability data. The data from these systems cannot be scaled up to design full-scale facilities.

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